

LEOMINSTER LOCAL PROTECTION

MONOOSNOC BROOK  
LEOMINSTER, MASS.

CHECKPOINT II CONFERENCE

26 SEPTEMBER 1977

LOCAL FLOOD PROTECTION

MONOOSNOC BROOK

LEOMINSTER, MASS.

NEW ENGLAND DIVISION

CHECKPOINT II CONFERENCE

26 SEPTEMBER 1977

AGENDA

1. Watershed Description
2. Project History
3. Alternatives Studied & Needs Identification
4. Basic Policy (Principles & Standards)
5. Selected Plan

Hydrology  
Economics  
Tunnel Construction and Materials  
Costs and Benefits  
Environmental

6. Controversial Issues
7. Summary

CHECKPOINT II

LEOMINSTER LOCAL PROTECTION

MONOOSNOC BROOK

LEOMINSTER, MASS.

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9. Project Costs and Justifications
10. Project Plans

DAEN-CWP-E (3 May 77) 1st Ind

16 June 1977

SUBJECT: Monosnoc Brook Flood Protection, Draft Feasibility Report,  
Leominster, Massachusetts

DA, Office of the Chief of Engineers, Wash D.C. 20314 16 June 1977

TO: Division Engineer, New England ATTN: NEDPL-P

1. The draft report does not demonstrate compliance with P&S guidelines and procedures prescribed in the ER 1105-2-200 series and EC 1105-2-71, particularly Appendices A-D, which require that the report describe the systematic process that led to a logical set of planning objectives and to the selected plan. Planning activities called for in Task 1 of the P&S have not been followed or have not been reported adequately. We suggest that the report coverage reflect P&S by:

- a. Identifying the scope and magnitude of the water and related land resource problems in the study area, in addition to the flood problem;
- b. Selecting problems and needs for further consideration or deleting them from consideration based on sound and adequately supported reasons;
- c. Developing a logical set of planning objectives or goals based on a and b above and on technical, economic and environmental criteria;
- d. Describing fully the management measures considered, alternative plans formulated and impact assessments followed in addressing each planning objective; and
- e. Discussing the evaluation procedures followed and the results of successive iterations of the basic planning process to reduce the number of plans, with emphasis on describing planning objective fulfillment for each alternative carried through stages 2 and 3.

2. Of the many water and related land resource problems and needs normally expected in an urban setting, only the flood problem is covered in detail, with the result that the planning objectives or goals are too narrowly defined. The report identifies flood control as the primary planning goal in the study area which implies that other goals were considered. Our review, to the contrary, indicates that because of the narrow planning perspective, problem solving was limited to flood control oriented solutions only. Possible solutions discussed on pages 20-22 of the report illustrate the point. Environmental degradation of the channel, water quality problems, and the need for urban open space along the floodway are described in the report and appendices, yet they are not carried forward as planning objectives or goals. The implication in the report that the responsibility for solving these problems is outside the Federal project is not an acceptable rationale for deleting them from consideration. The report should present sound reasons for selecting or deleting identified problems and needs without regard to ultimate responsibility for plan accomplishment.

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3. Technical, economic and environmental criteria shown on pages 18 and 19 include generalizations, assumptions and planning philosophy of dubious worth in reaching sound planning objectives. Normally, the criteria, together with the identified problems and needs, provide a basis for establishing planning objectives or goals. The criteria should be reviewed for relevancy.

4. Economic Evaluations:

a. The difference between flood control benefit values shown on page 36 and table H-9 (\$511,400) and those shown on table H-3 (\$433,371) should be explained.

b. On page C-6 annual losses are shown as \$433,980 for 1974 conditions. Under 1976 conditions, annual losses are estimated at \$524,900 on page H-8. A 25-percent increase for the two year period appears high as an adjustment for inflation and needs support.

c. We suggest the addition of stage-damage-discharge-frequency relationships for all damage reaches, in either graphical or tabular form, which were used to evaluate average annual flood damages with and without the considered project.

d. Business losses are mentioned on page 29, and it is reasonable to expect these in this heavily commercial and industrial flood plain. Documentation, however, should be provided to show how business losses and property damages were derived.

e. The effect assessment for formulating plans beginning on page F-21 is adequate. However, something more detailed than "yes" and "no" in the System of Accounts Tables would be desirable.

5. Draft EIS. The Draft EIS is considered adequate for discussing the impacts associated with the Tunnel Plan. However, more information should be provided to describe the likely impacts to lower Monoosnoc Brook in the event that stored water in the tunnel does become more highly degraded than is currently estimated. This discussion should also describe what the impacts would likely be for different flood events, i.e., the difference in impacts between small floods that only empty the tunnel (low dilution), compared with flood events of much greater magnitude (high dilution). This question was also raised by the Environmental Affairs Office, State of Massachusetts (Exhibit No. 2, Appendix 2 of the Report) in their letter of 15 April 1977. In addition, neither the report nor EIS discuss whether or not the tunnel will provide suitable habitat for mosquitoes. This should be addressed and the reports should be coordinated with appropriate public health agencies for their comments.

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#### 6. Engineering Comments.

a. Section D, page 9, paragraph 6, Flood Frequencies. Standard deviation and skew are generally inversely proportional to the drainage area. The values given imply a direct relationship. This should be explained and the method used to arrive at the mean value for Monoosnoc Brook should be explained.

b. Section D, page 12, paragraph 9; page 14, paragraph 9g and table 9. The rationale used to establish the modified Rockwell Pond elevation of 420.2 should be explained.

c. Section D, plate 8.. The one percent change flood should be shown also. Note numbered 6 should read 600-1500 cfs not 600-1000 cfs.

d. Section D, plate 9. The one percent change flood should be shown also for Monoosnoc Brook. Both the SPF and the one percent chance flood should be shown above Rockwell Pond.

#### 7. The Selected Plan.

a. We believe that the flood control plan described in the report should be enlarged to include, in addition to the Federally funded diversion, the existing channel of Monoosnoc Brook between the diversion inflow and outlet, Rockwell Pond, Rockwell Pond Dam, modification of Rockwell Pond spillway and Monoosnoc Brook downstream of the diversion outlet to the North Nashua River. The function of each part of the total plan should be discussed in quantitative terms.

b. Local cooperation should be reviewed for completeness. It may be appropriate to require local interests to operate and maintain not only the Federally funded diversion element but also the existing Monoosnoc Brook channel and Rockwell Pond. The precise method (legal right) local interest will employ to insure control and to maintain Rockwell Pond should be described in detail. If the rights to maintain are not firm acquisition may then be necessary. Proper functioning of the flood control project requires that the existing channel pass 600 and possibly as much as 1500 cfs and that storage in Rockwell Pond be protected from incompatible encroachment or uses. Additional items of local cooperation covering these points may be advisable.

c. Factual information on the various solutions considered would be helpful in understanding how and why certain plans were eliminated early in the planning process and others were carried through the system of accounts. Report statements that certain plans were too expensive or were socially or environmentally unacceptable without factual support only lends credence to allegations by Corps critics that we don't treat all solutions equally, particularly the nonstructural solution. It is even difficult to understand how the system of accounts tables provided any

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meaningful input in selecting the recommended plan. Merely answering yes and no to a list of effects is of little value in the selection process without supporting detailed information on the magnitude of the effect and on its seriousness and duration when compared to other effects. What is needed is the type of information that provides for a weighing of consequences and a balancing of trade-offs in the plan selection process.

8. Our comments above are meant to be constructive, as New England Division and the entire Corps cope with the increased planning sophistication required by Principles and Standards. We look forward to a high quality report consistent with past NED performance, whatever the criteria.

9. We suggest rescheduling of the Checkpoint II Meeting after consideration of our comments.

FOR THE CHIEF OF ENGINEERS:

wd all incl

ALEX SHWAIKO  
Acting Chief, Planning Division  
Directorate of Civil Works

## II. Checkpoint II, Milestone 06.

### A. Responsibility. (Same as IA)

B. Prior Information. The following will be furnished to OCE to reach the appropriate Reports Management Branch at least 10 days prior to date of conference:

#### (1) Summary of

- (a) Policy problems and issues as perceived by field.
- (b) Controversy.
- (c) Economic, social, and environmental effects.
- (d) Coordination and other public involvement.
- (e) Plan formulation and rationale.
- (f) Major design considerations.

(2) To the extent practicable, report draft material in hand may be submitted for the above with a cover memorandum indicating where key information may be found. Items a and b, however, should be prepared specifically for this conference.

C. Conduct of Sessions. The purpose of this conference is to discuss plan formulation and study problems and to check key factors that will give reviewers signals as to the adequacy of the investigation and analyses. Explicit presentation of the plan formulation procedure and rationale will be required. Details and numbers will be reviewed only to the extent absolutely necessary for understanding of key points. Presentations are to be concise, direct and devoid of window-dressing and jargon. An agenda should be prepared to insure coverage of the following with opportunity for discussion and overall summary. Topics may be combined as appropriate for presentation.

(1) Hydrologic and foundation investigations and conclusions as to site and structure selection.

(2) Needs identification.

(3) Response of last iteration of alternatives to meeting needs and resolving problems.



## LEOMINSTER LOCAL PROTECTION

### MONOOSNOC BROOK

Slide #1 - This is the Monoosnoc Brook watershed.

The city proper is located at the downstream end. Most of the upstream terrain is steep and hilly. Although mostly forested, rainfall and snowmelt run-off is very rapid creating frequent high water conditions through the restricted channels in the city. Notown Reservoir does modify rainfall runoff from the west side of the Monoosnoc Hill area.

Slide #2 - This shows water running in the streets near Pleasant and Cottage Streets during the flood of October 1955. Bear in mind that this was only the fourth largest event in the last 40 years.

Slide #3 - Here also we have flooding at Cottage Street during the same event.

Slide #4 - This is a view of Rockwell Pond looking northwest from Pond Street. This is the area of the proposed intake structure.

Slide #5 - The following photos show the existing channel as it looks today. This slide was taken facing downstream from Pond Street. Encroachment on the stream

by buildings is typical throughout its length in the city.

Slide #6 - View of channel looking downstream from Cotten Street Bridge.

Slide #7 - Looking downstream toward restricted area where channel goes under a three-story woodframe building (former Standard Pyroxaloid Company).

Slide #8 - This slide was taken facing downstream from Adams Street. Residential as well as commercial buildings crowd the stream with little or no protection against flooding conditions.

Slide #9 - Looking upstream toward culvert under Mechanic Street. This is just downstream from the central business district of Leominster.

Slide #10 - Looking downstream toward culvert entrance under Tilton-Cooke Company parking lot.

Slide #11 - View of Pyrotex Co. Bldg--Monoosnoc Brook is located at right side of photo. This is the area to be filled and regraded which is located downstream from the proposed tunnel outlet.

Slide #12 - This slide show the general location of the proposed tunnel in relation to the brook location.

Slide #13 - This artist conception shows the proposed tunnel intake structure at Rockwell Pond.

Slide #14 - This artist view shows the proposed tunnel outlet structure.

Slide #15 - This is a view of a typical lined tunnel as it would appear under the streets of Leominster.

3. WATERSHED DESCRIPTION. The Monoosnoc Brook Watershed is located primarily within the corporate boundaries of Leominster, Massachusetts, with a small portion located in adjacent Fitchburg. Monoosnoc Brook is within the North Nashua River Basin, which is tributary to the Merrimack River. Leominster is located in north central Massachusetts, about 40 miles west of Boston, 25 miles north of Worcester, and 210 miles northeast of New York City.

The watershed is comprised of two significant contrasting areas. The rural upper basin and the urbanized lower area are separated by Rockwell Pond, which is just upstream of the city proper.

Steep forested hills with some large rock outcropping typifies the upper basin. Several reservoirs and ponds are scattered along the upper Monoosnoc and its tributaries. Although the area is primarily virgin woods, especially within the Leominster State Forest, steep slopes make the upper basin conducive to rapid runoff.

Monoosnoc Brook is a fairly steep stream having a total fall of 550 feet along 8.7 miles, and controls approximately 11.5 square miles of drainage area at its mouth. Rising in the rural forested hills in western Leominster in Rocky Pond, and reservoirs on other smaller tributaries, the brook flows easterly, roughly paralleling U.S. Route 2, through several small impoundments in residential areas to Rockwell Pond, just upstream of the city proper. Downstream of Rockwell Pond, the lower basin is characterized by urbanization and channelization. Manufacturing, retail structures and multi-family housing crowd the brook into channels and closed conduits through the city. Continuing downstream from Rockwell Pond, Monoosnoc Brook passes under one railroad and nine highway bridges in its course through the congested area of the city, a distance of approximately 2.3 miles. Downstream, below William Street, the stream slope flattens out on a large floodplain to the confluence with the North Nashua River. Searstown, a major shopping center and retail area, is being built on this floodplain.

1. PROJECT STUDY HISTORY. Monoosnoc Brook has a long history of flooding within the City of Leominster. Insufficient flood storage upstream, a cluttered channel through the city proper, and undersized culverts cause the brook to overtop its banks, incurring damages almost annually to the downtown business and industrial areas of the city.

Local flood protection improvements along Monoosnoc Brook were recommended for the City of Leominster in the North Nashua River Basin Report (NNRBR) by the New England Division dated 25 January 1965. Recommended improvements included an upstream multi-purpose, 90 acre reservoir, providing a storage capacity of 2000 acre-feet, 1200 of which was for water supply and recreation and 800 for flood control. Proposed channel improvements along the river consisted of removal and replacement of existing walls, removal of a small dam, capping of old walls, stone slope protection, and general clearing and realignment of portions of the existing channel. Additional contiguous improvements were proposed in an Urban Renewal project through the central business district. The improvements would have relocated 2400 feet of channel, removed four undersized bridges and improved the existing channel where required. The Urban Renewal Project was an integral part of the overall flood damage prevention project for Monoosnoc Brook and would have had to be accomplished by local interests.

The Urban Renewal Project was rejected by the Leominster City Council in its entirety on 30 September 1969 and the Mayor requested that consideration be given to modifying the Corps' original plan to include the entire channel for improvements. Due to the necessity to reassess the engineering feasibility and economic justification of a revised continue project and the degree of local participation, the project was reclassified to a "deferred category" in November 1969. The Monoosnoc Lake project, as authorized, would have provided storage for flood control, water supply and recreation. Since the time of project authorization, the City of Leominster has made arrangements with the Commonwealth of Massachusetts, Metropolitan District Commission, for additional water supply and is no longer a project purpose. Therefore, it was necessary to review the project feasibility and economics of providing an upstream dam only for flood control storage and recreation, and the project was reclassified to a deferred status in July 1971.

Although conditions have remained fairly constant through the city proper since 1965, other physical features along the brook have changed significantly. A large shopping center was started on the flood plain at the confluence of the Monoosnoc Brook and the North Nashua River in January 1966. Portions are still under construction. The development eliminates a sizable portion of the natural flood storage area along the brook.

State and local interests desire Federal assistance to solve the flood problems and to enhance the area within environmental guidelines.

On 5 June 1972, Congressman Robert F. Drinan, Mayor Crossman of Leominster, and other local officials requested that the Monoosnoc Brook and Lake Project be reactivated and removed from its deferred status. No resolution was required to undertake the restudy, as it was originally authorized under the Flood Control Act of 1966 (Senate Document 113/89/2). The restudy was started in August 1974 and funded by the Public Works Appropriation Act of 1975 (Public Law 93-393 dated 28 August 1974), under the general investigation provision.

## ALTERNATIVES STUDIED

THE MONOOSNOC BROOK WATERSHED IS 11.5 SQUARE MILES IN AREA AND IS LOCATED PRIMARILY WITHIN THE CITY OF LEOMINSTER, WITH A SMALL PORTION OF THE DRAINAGE BASIN IN FITCHBURG. SEVERAL RESERVOIRS FOR WATER SUPPLY ARE LOCATED IN THE UPPER BASIN ON THE BROOK'S MAIN STREAM AND TRIBUTARIES. DURING PERIODS OF HEAVY RAINFALL, RUNOFF FROM THE MONOOSNOC BROOK WATERSHED RESULTS IN PERIODIC FLOODING IN THE CONGESTED CENTRAL BUSINESS DISTRICT OF LEOMINSTER.

DURING THE COURSE OF OUR STUDY SEVERAL ALTERNATIVE PLANS FOR LOCAL FLOOD PROTECTION IN LEOMINSTER WERE CONSIDERED. ALL WERE SUBJECT TO THE LIMITATIONS OF PHYSICAL, SOCIAL, ENVIRONMENTAL AND DEMOGRAPHIC FEATURES OF THE AREA.

FIRST, THE PROJECT, AS AUTHORIZED IN 1965, WAS REVIEWED. A PLAN FOR LOCAL FLOOD PROTECTION WHICH HAD BEEN AUTHORIZED IN 1965 AND INCLUDED CHANNEL IMPROVEMENTS THROUGH THE CITY AND A DAM TO BE LOCATED JUST UPSTREAM OF EXCHANGE STREET WAS RE-EXAMINED. HOWEVER, DEVELOPMENT IN THE CARTER HILL AREA AND THE ELIMINATION OF WATER SUPPLY AS A PROJECT NEED AS WELL AS THE DECISION TO SUSPEND URBAN RENEWAL DEVELOPMENT RESULTED IN A LOSS OF BENEFITS FOR THE OVERALL CONSTRUCTION. MODIFICATION OF THE DAM LOCATION BY MOVING IT UPSTREAM ALSO LACKED ECONOMIC JUSTIFICATION.

A SURFACE DIVERSION WAS ALSO CONSIDERED. DIVERTING FLOOD FLOWS FROM PIERCE POND TO THE NORTH NASHUA RIVER, TO BE ACCOMPLISHED IN CONJUNCTION WITH CHANNEL IMPROVEMENTS WAS NOT FEASIBLE BECAUSE OF EXTENSIVE DEVELOPMENT ON THE DIVERSION ALIGNMENT.

OTHER METHODS OF FLOOD PROTECTION WERE REVIEWED. FLOOD PROOFING DAMAGABLE PROPERTY WAS DISCOUNTED AS DIFFERENTIAL PRESSURES DURING FLOOD PERIODS COULD CONTRIBUTE TO STRUCTURAL FAILURE OF OLDER BUILDINGS.



NON-STRUCTURAL METHODS SUCH AS EVACUATION AND FLOOD PLAIN ZONING WERE CONSIDERED BUT THESE METHODS WOULD INVOLVE SUBSTANTIAL LOCAL COSTS AND WOULD BE HIGHLY DISRUPTIVE TO THE CORE AREA OF THE CITY.

AFTER A STUDY OF ALTERNATIVE METHODS OF LOCAL FLOOD PROTECTION FOR MONOOSNOC BROOK IT WAS DETERMINED THAT THE ONLY PLAN OF FLOOD CONTROL IMPROVEMENTS HAVING ECONOMIC JUSTIFICATION WAS A DEEP ROCK TUNNEL UNDER THE COMMERCIAL CENTER OF LEOMINSTER.

# BASIC POLICY

1. The Leominster, Mass. water resource study is basically a restudy of an authorized flood control project (Flood Control Act of 1966-Senate Document 113/89/2). It has, therefore, been mandated by the authorizing document that flood control is the primary purpose for current water resource planning along Monoosnoc Brook. Consequently P&S evaluations for the NED and EQ accounts are more focused on flood control planning than on other water and related land use objectives.
2. The use of the word primary does imply that other needs were considered. Pages 16-17 of the report states that water supply needs were indeed investigated. However, because present and future water supply demands have been met by supplemental acquisition from the Metropolitan District Commission, via their Quabbin Reservoir System, this is no longer a viable subject for further analysis and expenditure of funds.
3. Page 30 of the draft report indicates that continued conservation and recreation opportunities would be realized from preservation of the natural woodlands in the upper watershed. Of course construction of a dam in this area would preclude continued use of these areas due to inundation, either by a permanent multi-purpose impoundment or from periodic flood control storage although water based recreation use could be obtained at a reservoir. However, the positive economics of such construction in this small watershed, due to the lack of potential sites, is non-existent.
4. The concept of urban planning for increased utilization of open space such as "green belts" was an integral part of studies prior to the 1966 authorization. The proposed channel restoration through Leominster included two zones of urban renewal construction. However, these plans for urban renewal were rejected by Leominster officials, as noted on Page 13 of the draft report. Therefore, it is evident that the acceptability evaluation criteria was not met thereby precluding this aspect from further iterations. This proposal for Urban Renewal has not been revived by Leominster City Officials.
5. Because of the loss of recreation, water supply and urban renewal

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we were basically required to concentrate on the one water resource aspect (flood control) which is needed within the community. This was brought out at the Public Meeting, where flood control improvements were the only topic of concern to local residents. Although the report does concentrate on the single, more narrow water resource solution it does satisfy the requirements of development of the EQ and NED plans. In this case the EQ plan is the tunnel by-pass, as it is the least environmentally damaging of all alternatives investigated. It is also the only plan having economic justification.

6. We appreciate your comments prior to BERH review, but there appears to be a basic misunderstanding on this matter of an emergence of new Corps policy as relates to Principles and Standards for authorized projects. If the latter is the case there will be several other projects which will be further delayed and require additional large expenditures to determine other water and land related resources. If there is a misunderstanding involved I trust this memo will provide adequate explanation of our understanding of P&S proceedings for authorized projects.

## PROJECT DESCRIPTION

The proposed Rockwell Pond by-pass tunnel would divert anticipated flood flows above the densely propulated commercial and residential area via a 3,200 feet long deep rock tunnel to a point approximately 900 feet downstream of the Rochdale Dam below Water Street. With a design discharge of 3,400 cfs. flow velocity in the tunnel is estimated to be 28 feet per second. The diversion project would in effect reduce the flow in Monoosnoc Brook as it passes through the center of Leominster, thus giving this section of town adequate flood protection. Monoosnoc Brook would be flowing at a non-damaging channel capacity of 600 cfs.

The proposed spillway inlet would be located in Rockwell Pond just upstream of the existing dam. The circular intake structure would have a diameter of 46.64 feet, at a weir crest elevation of 410.7 msl. A galvanized steel grating would be placed over the intake as a safety measure and to prevent trash from entering the tunnel. The shaft would drop 90 feet below the assumed bedrock surface of elevation 398 feet msl to the tunnel invert of 308 feet msl. The shaft diameter would be 14 feet to elevation 348 feet msl with a transistion to 12 feet in the neck between elevations 348 and 338 feet msl. The 3,200 foot long tunnel would be drilled through rock and would have a concrete or steel linear to prevent any intrusion of

ground water. The invert of the tunnel would slope to elevation 264 msl at the outlet shaft. The concrete outlet structure would widen to 32 feet at an invert elevation of 320 feet msl. A discharge channel would be excavated from this area for a distance of about 250 feet to the existing channel. Although discharge velocities will not cause erosion in the channel, either concrete blocks or large rocks will be placed in the channel to provide sheltered areas for fish habitat.

The present dam maintains the level at Rockwell Pond by a weir about 13 feet high with a crest elevation at 415.7 feet msl and effective length of 68 feet. The proposed improvement would modify the existing dam by reducing the effective length of the weir to 22.5 feet while maintaining the same crest elevation. This elevation is one foot less than the proposed diversion crest and would, therefore, allow normal flow passage of up to 70 cfs downstream through Leominster in the Monoosnoc Brook channel, before the diversion goes into automatic operation.

Additional construction would include regrading of about 3.5 acres of flood prone property at the Pyrotex Company located about 300 feet downstream from Whitney Street. Existing ground which is as low as elevation 309 msl would be sloped from the riverbank to an elevation of 317 msl near the building. A plan of the proposed regrading is shown on Plate 5.

Two existing sewer lines which cross the river under the Whitney Street Bridge and at the end of Williams Street would be relocated downstream or replaced as a syphon under the brook at these locations.

In general, this planned improvement is intended to divert excess flow from Monoosnoc Brook and would not take normal flow away from the brook. The design capacities are such that existing conditions will be maintained above and below the diversion.

### CONSTRUCTION

Assuming the authorization and availability of construction funds, it is estimated that the project could be designed and constructed in about three years. The actual construction period is estimated to be less than two years.

During the construction phase, earth fill would be required for the temporary worksite at Rockwell Pond in order to construct the proposed spillway. Estimated rock excavation for a 3,200 feet length of tunnel will be 20,500 cubic yards. Excess excavation materials would be disposed of by the contractor at Government approved disposal sites. Concrete required for the intake and outlet structures, and the tunnel itself is estimated at 8,780 cubic yards.

All necessary easement lands, temporary and permanent, would be restored to their natural environmental setting after construction.

TABLE H-2  
ESTIMATED COST OF SELECTED PLAN

<u>Federal Cost</u>				
<u>Item</u>	<u>Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
Preparation of Site	1	JOB	L. S.	\$ 20,000
Gen. Earth Excavation	6,400	C. Y.	7.00	44,800
Tunnel Rock Excavation	20,500	C. Y.	70.00	1,435,000
Shaft, complete	161	V. F.	8000.00	1,288,000
Open Rock Excavation	110	C. Y.	25.00	2,750
Gravel Fill	1,500	C. Y.	6.40	9,600
Dumped Gravel Fill	1,100	C. Y.	5.40	5,940
Gravel Bedding	800	C. Y.	6.40	5,120
Concrete:				
Intake Structure	430	C. Y.	130.00	55,900
Tunnel	7,400	C. Y.	145.00	1,073,000
Outlet Structure	450	C. Y.	120.00	54,000
Mass	500	C. Y.	60.00	30,000
Portland Cement	60,800	CWT	2.80	170,240
Tunnel Grout	10,000	C. F.	14.00	140,000
Steel Reinforcing	549,000	LB	0.40	219,600
Rock Bolts	2,500	EA	54.00	135,000
Steel Bents	150	EA	450.00	67,500
Drains	210	EA	80.00	16,800
Waterstop	13,600	LF	9.00	122,400
Stone Protection	720	C. Y.	25.00	18,000
Topsoil	2,700	C. Y.	7.50	20,250
Seeding	3.25	Acre	2,500.00	8,125
Dewatering (tunnel)	1	JOB	L. S.	320,000
6' Security Chain				
Link Fence	170	L. F.	13.00	2,210
Miscellaneous Metals:				
Struct. Steel, Standard	6,400	L. B.	0.40	2,560
Struct., Steel, Curved	2,300	LB	0.60	1,380
Galv. Steel Floor Grate	1,820	S. F.	8.00	14,560
Galv. Steel Safety Grate	8,400	L. B.	0.75	6,300
2'x2' Sluice Gate	1	E. A.	300.00	300
Subtotal				\$ 5,289,335
Contingency				810,665
TOTAL CONSTRUCTION COST				\$ 6,100,000

Engineering & Design  
Supervision & Administration

390,000  
~~370,000\*~~  
510,000

TOTAL ESTIMATED FEDERAL FIRST COST <sup>7,000,000</sup>~~\$6,980,000~~

NON-FEDERAL COST

Q      Lands & Damages                      450,000  
      Utility Relocations                    150,000

TOTAL ESTIMATED NON-FEDERAL FIRST  
COST    600,000

TOTAL ESTIMATED PROJECT FIRST COST <sup>600</sup>~~\$7,580,000~~

\*Does not include preauthorization cost of \$210,000.

*Handwritten mark*



## JUSTIFICATION

The estimated annual costs, annual benefits and the ratio of benefits to costs <sup>for the selected plan</sup> are summarized in Table H-<sup>5</sup>~~9~~. This analysis indicates that the plan of improvements to provide flood <sup>protection</sup> location along Monoosnoc Brook is economically justified.

TABLE H-<sup>5</sup>~~8~~  
SUMMARY OF ECONOMIC ANALYSIS

### Average Annual Benefits

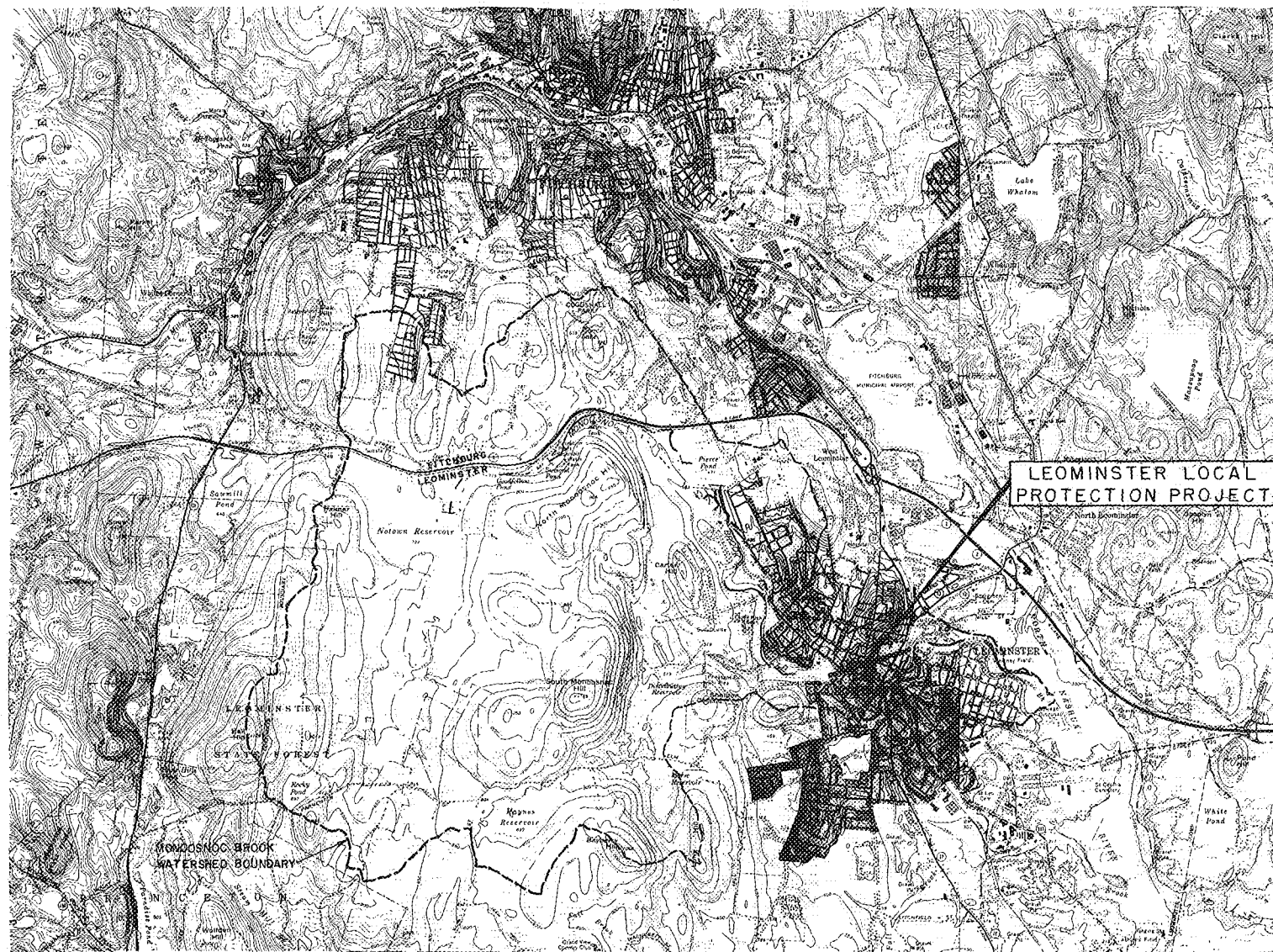
Flood Damage Prevention	\$511,400
Area Redevelopment	<u>72,000</u>
Total	\$583,400

### Average Annual Costs

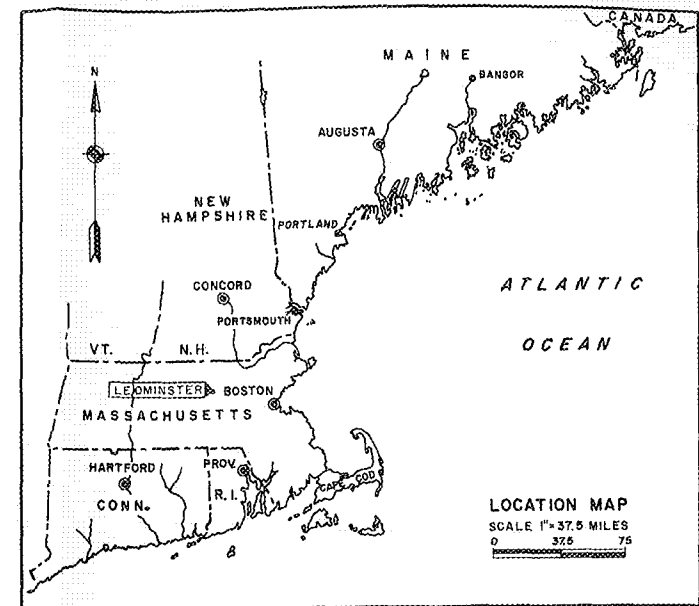
\$486,000

### Economic Ratio

Benefit/cost (without area redevelopment)	1.05
Benefit/cost (with area redevelopment)	1.20



BASIN MAP

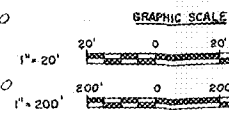
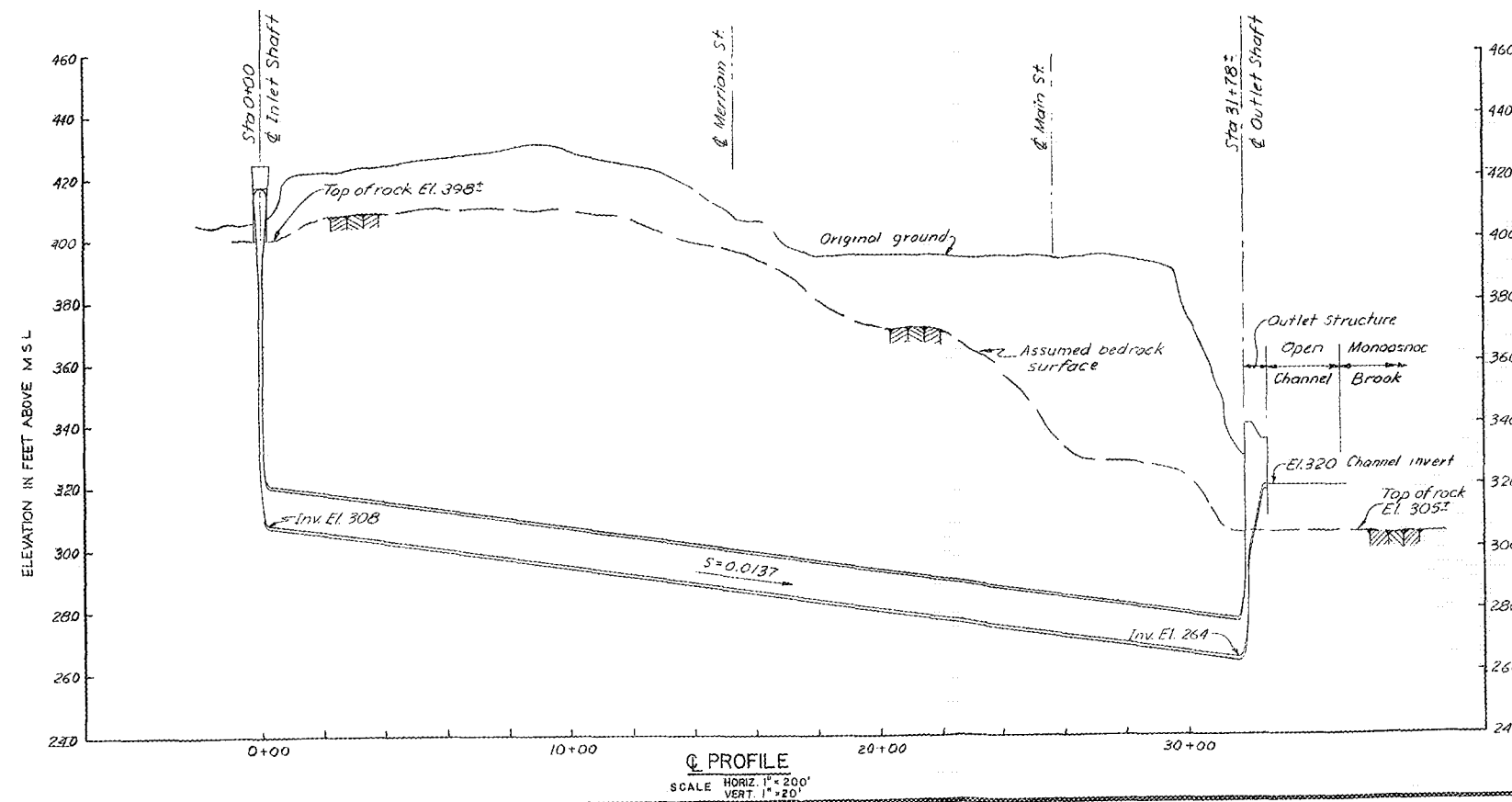
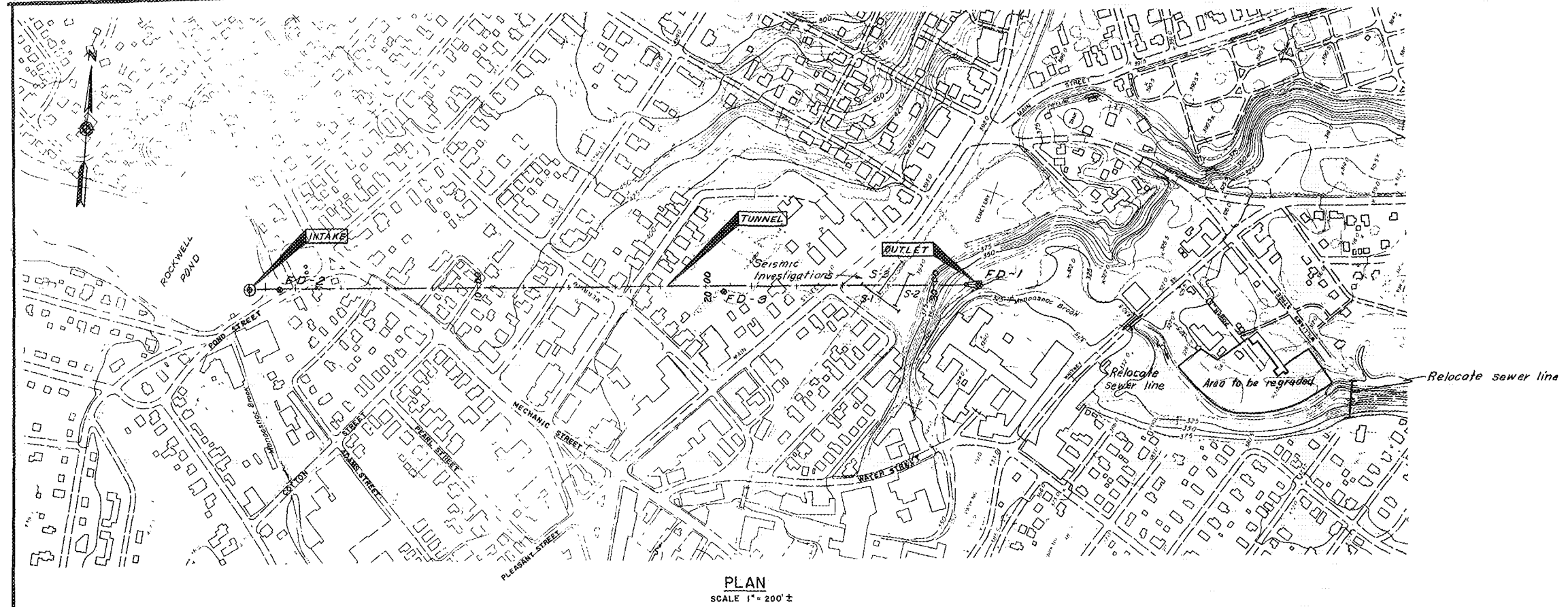
SCALE IN FEET  
2000 0 4000 8000**PRELIMINARY**

REVISION	DATE	DESCRIPTION	BY

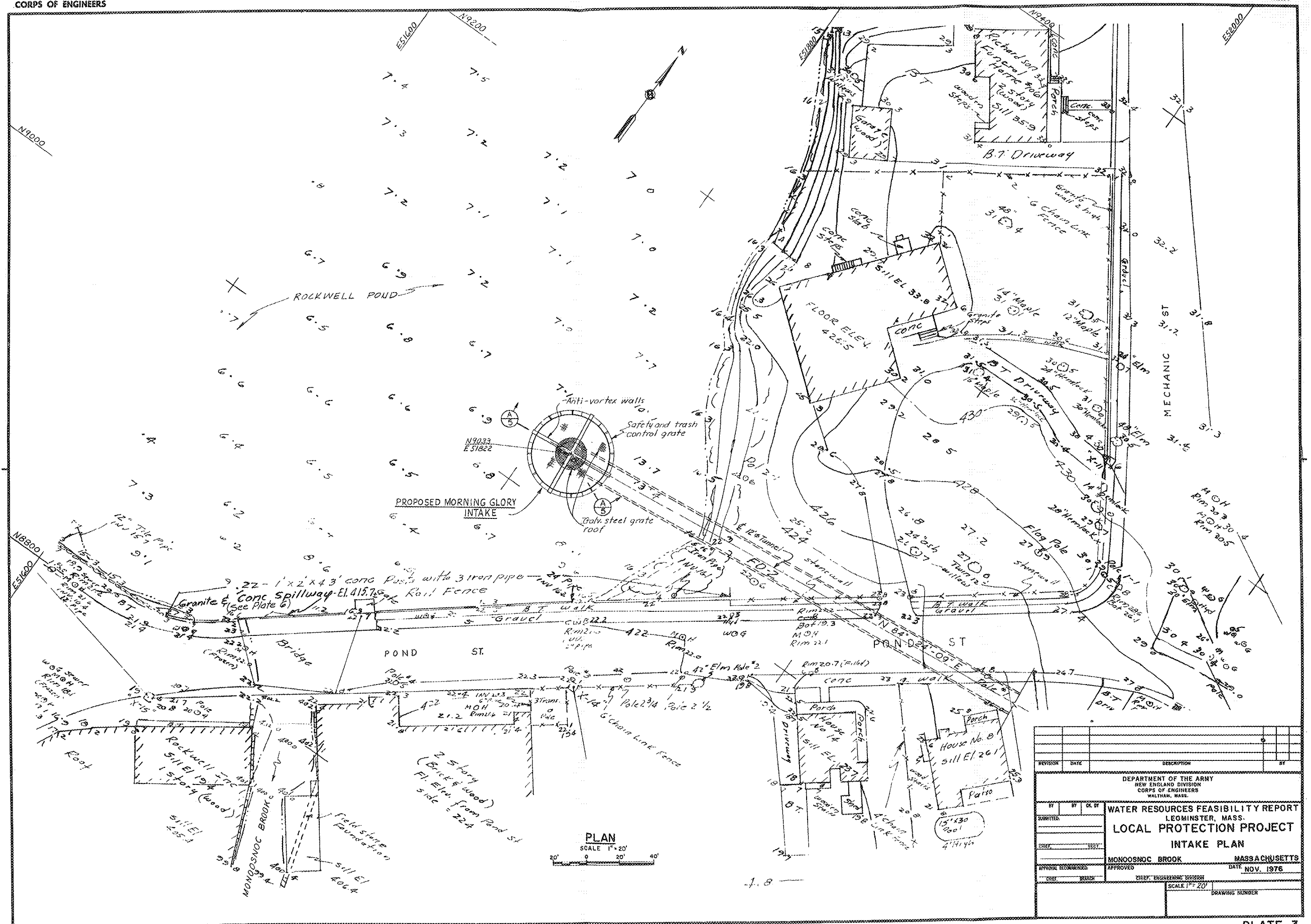
DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION  
CORPS OF ENGINEERS  
WALTHAM, MASS.

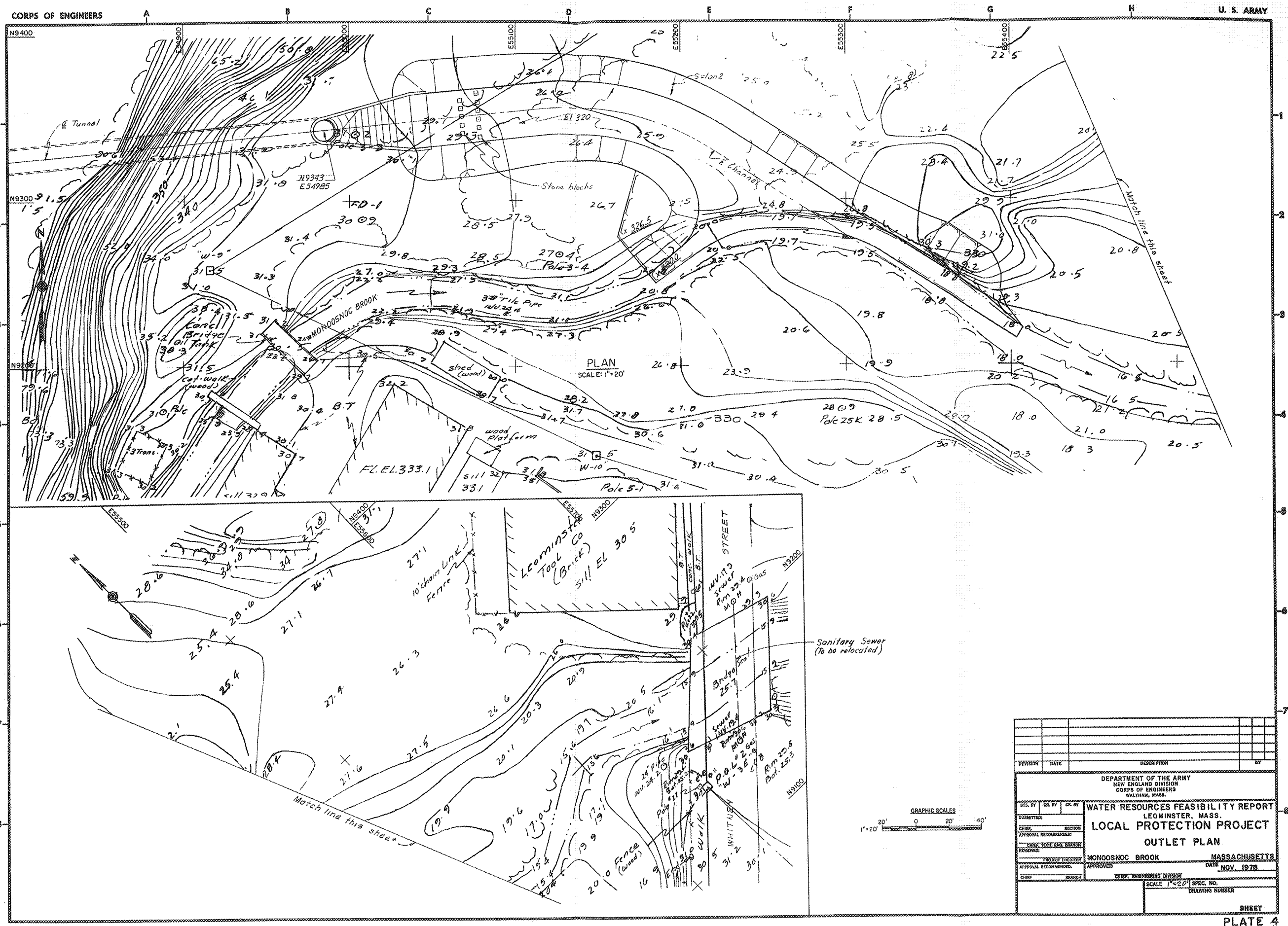
DR. BY: TR. BY: EX. BY: PROJECT ENGINEER  
SUBMITTED: PROJECT ENGINEER  
REVIEWED: CHIEF, CIV. & ENV. DIVISION  
APPROVAL RECOMMENDED: CHIEF, CIV. & ENV. DIVISION

WATER RESOURCES FEASIBILITY REPORT  
LEOMINSTER, MASS.  
LOCAL PROTECTION PROJECT  
BASIN MAP  
MONOOSNOC BROOK MASSACHUSETTS  
DATE NOV 1976  
APPROVED: CHIEF, ENGINEERING DIVISION  
SCALE: SPEC. NO. DACW 33  
DRAWING NUMBER  
SHEET



REVISION	DATE	DESCRIPTION	BY
DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTON, MASS.			
WATER RESOURCES FEASIBILITY REPORT LEOMINSTER, MASS.			
LOCAL PROTECTION PROJECT GENERAL PLAN & PROFILE			
MONOASNOC BROOK MASSACHUSETTS			
DATE NOV 1976			
SCALE AS SHOWN SPEC. NO.			
DRAWING NUMBER			
SHEET			





REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MASS.			
DES. BY	CHK. BY	WATER RESOURCES FEASIBILITY REPORT	
SUBMITTER	SECTION	LECOMINSTER, MASS.	
CHIEF	APPROVAL RECOMMENDED	LOCAL PROTECTION PROJECT	
CHIEF TEST BLDG. BRIDGE	APPROVED	OUTLET PLAN	
PROJECT NUMBER	DATE	MASSACHUSETTS	
APPROVAL RECOMMENDED	DATE	NOV. 1978	
CHIEF	BRANCH	SCALE 1"=20' SPEC. NO.	
		DRAWING NUMBER	
SHEET			





